Disaster Recovery and Long-Term Resilience Planning in Vermont

U.S. EPA Smart Growth Implementation Assistance Project
Guidance Document for the State of Vermont
August 2013

Credit: Lars Gange & Mansfield Heliflight.

Caption: Images of flood damage in Vermont communities from Tropical Storm Irene.

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Background on the Project

The U.S. Environmental Protection Agency (EPA) Office of Sustainable Communities and the Federal Emergency Management Agency (FEMA) partnered to provide technical assistance to the State of Vermont and local communities in the Mad River Valley (MRV) through the EPA's Smart Growth Technical Assistance (SGIA) program. The SGIA program helps state, local, regional, and tribal governments that need tools, resources, and other assistance to achieve their growth- and development-related goals. The state of Vermont requested assistance after many communities across the state experienced damage from Tropical Storm Irene in 2011. The state was specifically interested in obtaining assistance so they could help communities throughout the state plan and prepare for future flooding events.

The goal of this assistance is to help communities incorporate smart growth and sustainable community approaches into their development plans, regulations, and hazard mitigation plans to increase their flood resilience. As used in this memo, "flood resilience" means measures taken to reduce the vulnerability of communities to damage from flooding and to support recovery after an extreme flood. "Smart growth" describes development patterns that create attractive, distinctive, and walkable communities that give people of varying age, wealth, and physical ability a range of safe, convenient choices in where they live and how they get around. Growing smart also means using existing resources efficiently and preserving the land, buildings, and environmental features that shape our neighborhoods, towns, and regions. Implementing smart growth approaches to development can help communities become more resilient to future flooding events by locating development in safer locations and designing development so it is less likely to be damaged during flooding events.

To provide assistance, EPA hired consultants to review local development regulations, community plans, and hazard mitigation plans for two communities in the MRV—Waitsfield and Moretown. The consultants developed a menu of policy options that Waitsfield and Moretown officials, and officials from communities throughout the state, can consider as they update and strengthen their policies and strategies to improve flood resilience. As communities consider what options they might pursue, they might choose to collaborate with neighboring jurisdictions in the region, recognizing that policy changes made in one part of the watershed may affect other neighboring communities.

Credits: Lars Gange and Mansfield Heliflight (left), Jeff Knight, The Valley Reporter (right).

Caption: Images of the flood damage in the Mad River Valley from Tropical Storm Irene, including a damaged home along Vermont Route 100 between Middlesex and Waitsfield (left) and a damaged building in Waitsfield (right).

Specific policy options for Waitsfield and Moretown were described in a separate Policy Memo also developed as a part of this project. Building on that Policy Memo, this memo offers policy options to other communities in Vermont and across the country for strategies to improve long-term flood resilience.

This work is being coordinated with a parallel project funded by FEMA. FEMA hired a consultant team from the University of North Carolina at Chapel Hill's Department of Homeland Security Coastal Hazards Center of Excellence (CHC). The CHC team conducted an analysis of barriers to flood disaster response and recovery at the state level, including the degree to which state programs and policies support or hinder local governments' ability to incorporate smart growth approaches and flood resilience measures into their planning at the local and regional levels.

Purpose of the Document

Many communities across the country have experienced flood-related damage in the wake of storms such as Tropical Storm Irene in 2011 and, more recently, Superstorm Sandy in 2012. Damage from these storms has resulted in billions of dollars of damage and has taken hundreds of lives.[1,2] Many affected communities have responded to flood disasters with expensive, engineered solutions such as elevating buildings, constructing levees and floodwalls, and armoring banks. Despite taking such measures, annual flood damage losses in the United States continue to grow.[3] Climate change projections suggest that the frequency and intensity of severe storms may be increasing, so many communities are addressing flood resilience in their communities with greater urgency.

Communities that have been, or will be, affected by flood-related losses are all different. They may be urban, suburban, or rural, and they may vary in their financial and staff resources, ability to access accurate flood data, and state enabling legislation which may provide more or less autonomy for local decision-making. Nevertheless, many state, regional, and local governments recognize the need to integrate their pre-disaster hazard mitigation plans and post-disaster resilience efforts with their land use plans and regulations that direct where and how development will be built and rebuilt in the future.

This memo is intended to offer a menu of strategies and land use policy options for communities in Vermont and around the country to consider as they seek to improve their resilience to future flooding events. In order to develop such policies, communities should use reliable data on demographics, flood damage, stormwater flows, and river science. This data can help inform communities about which policies will be most effective in reducing risks associated with flooding events. Such data also enables local governments to apply for state and federal funding for flood hazard planning and recovery.

Overall Strategies to Enhance Resilience

Land use decisions that affect a community's flood resilience may seem to happen incrementally or opportunistically, but they are often informed by plans, policies, and regulations that guide development over time. Communities seeking to enhance their ability to withstand and recover from flooding-related disasters in the future may wish to consider updating, coordinating, and revising their plans, policies, and regulations to ensure that they are consistent with the community's resilience goals and objectives. Several basic steps may help communities get started on their road to resilience.

1. Update and coordinate community plans and hazard mitigation plans (HMPs).

Most states require local governments to adopt comprehensive/community plans to guide future land use decisions. State governments and FEMA also require communities to prepare Hazard Mitigation Plans (HMPs), to improve planning for, response to, and recovery from, disasters. An HMP identifies

policies and actions that can be implemented over the long term to reduce risk and future losses.[4] HMPs serve as a prerequisite to receiving disaster planning funds and post-flood damage recovery assistance.

Unfortunately, communities rarely coordinate their community plans with their HMPs. Community plans are often silent on the topics of hazard planning and resilience, and many HMPs do not discuss land use tools that can be used to guide future development away from known flood hazard areas. In many communities, local planning and zoning staff are not involved in the preparation of HMPs just as emergency response personnel are often not involved in the community land use planning process.

In order to improve flood resilience, communities could better coordinate the process of developing and implementing their community plans and HMPs. They could ensure that the necessary stakeholders involved in resilience planning are involved in developing the community plan and that local planners are involved in developing the strategies outlined in the community's HMP. Ensuring that community plans and HMPs are coordinated and consistent with each other can help provide decision-makers with clear priorities for determining what infrastructure is at risk in their communities and can outline a strategy for fostering growth in safer locations. Coordinating these plans and implementing the appropriate policies, regulations, and strategies to make these plans a reality can also place communities in a better position to compete for post-disaster assistance if and when the next disaster occurs.

To further increase the effectiveness of community plans and HMPs, communities can also ensure that their capital improvement plans and budgets match the priorities outlined in their community plans and HMPs and can prioritize capital improvements that are located in safer, less vulnerable locations.

2. Conduct thorough regulatory audits (including the resilience checklist).

After coordinating and updating their community plans and HMPs, communities may wish to undertake a thorough assessment or audit of their zoning, subdivision, stormwater management, and other regulations. By assessing whether current regulations will enable a community to achieve the goals in their plans, that community can identify which regulations may need to be updated and where new regulations may be helpful. These kinds of analyses are typically called capability assessments in HMPs. The checklist in Appendix A of this document can provide a starting point for communities that are interested in conducting a regulatory audit to enhance resilience. The checklist is intended to help communities identify opportunities to improve their resilience to future flooding events through policy and regulatory tools. Other scorecards and checklists, such as the Vermont Natural Resources Council's *Resilient Communities Scorecard*, may also help Vermont communities assess their resilience in key areas including transportation, energy, housing, land use, and healthy community design.[5]

3. Amend zoning, subdivision, and stormwater regulations to match plans.

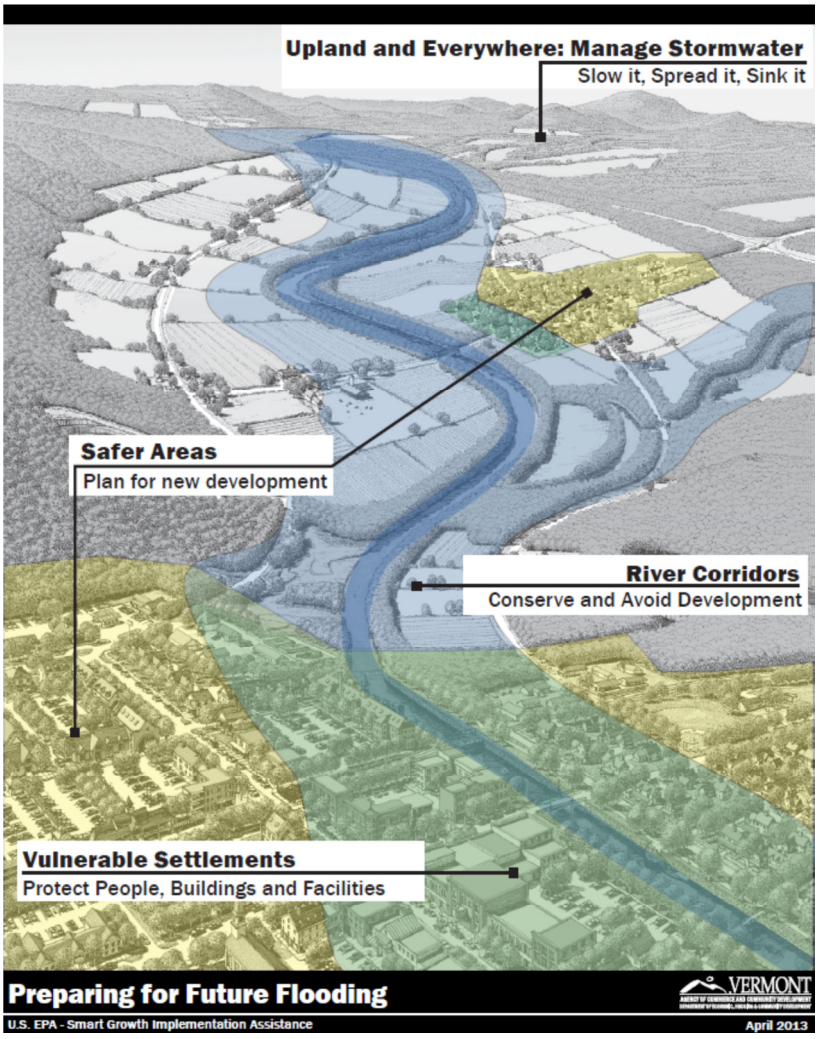
After they conduct an analysis of existing regulations, communities are well-positioned to update and amend those regulations to match the goals outlined in their plans. The rest of this memo outlines several policy and regulatory options that communities may wish to consider as they implement their resilience goals.

Land Use Policy Options to Improve Flood Resilience

The section below outlines several policy options that communities can consider implementing to increase flood resilience in the future. Communities can choose which options fit their community context and can tailor the policies to fit their needs. The policy options are organized into four geographically-oriented categories for areas within a community:

A. **River Corridors:**[i] Conserve land and avoid development in particularly vulnerable areas such as floodplains and river corridors;
B. **Vulnerable Settlements:** Where development already exists in vulnerable areas, protect people, buildings, and facilities to reduce future flooding risk;
C. **Safer Areas:** Plan for and encourage new development in areas that are less vulnerable to future flooding events; and
D. **Upland and Everywhere:** Implement stormwater management techniques to slow, spread, and sink floodwater.

The policy options within these categories offer multiple and interrelated benefits. For example, directing development out of floodplains not only keeps people and property safe, it also protects the ability of floodplains to hold and slow down floodwaters before they reach downstream settlements.



Credit: State of Vermont.

Caption: This graphic illustrates the four categories of policy options to enhance resilience to future flooding events: River Corridors, Safer Areas, Vulnerable Settlements, and Upland and Everywhere.

[i] For the purposes of this project, "River Corridors" are areas of land that include the river channel and adjacent lands needed for the river to adjust laterally over time and still maintain its natural stable form.

A. River Corridors: Conserve land and avoid development in particularly vulnerable areas such as floodplains and river corridors.

Communities that wish to reduce future flood risk can consider conserving land and avoiding development in particularly vulnerable areas, including floodplains and river corridors. Conserving land in these areas can help accommodate water during flooding events. Avoiding development in these areas can reduce the risk that homes, businesses, and critical infrastructure will be damaged in such flooding events. Several policies can help conserve land and avoid development in particularly flood-prone locations.

1. Acquire or protect land in flood-prone locations and remove vulnerable structures.

To accommodate water during flooding events and reduce the risk that homes, businesses, and critical infrastructure will be damaged, communities can acquire or protect land in flood-prone locations. Vulnerable land can be protected in several ways. Communities can partner with landowners and land trusts or other organizations to purchase land outright or acquire conservation easements on undeveloped properties along a river, such as farm or forestland, to ensure that the land remains undeveloped and retains its ability to accommodate floodwater. The Vermont Planning Information Center has information on open space and resource protection programs that may be helpful.[6] Communities may also work with FEMA or state agencies to identify properties that have been repeatedly flooded, and when funding is available, coordinate buyouts of those properties.[7] They can also provide incentives for conserving vulnerable land through Transfer of Development Rights (TDR) programs and by providing tax incentives.[ii]

The first step in an acquisition program is to establish clear goals for the program and identify potential funding mechanisms. The community may wish to identify priority lands to protect based on community goals and flooding risk. Funding sources for acquisition programs (depending on state enabling legislation) may include sales taxes (many communities across the United States, notably in Colorado,[8] use this source), general obligation and revenue bonds, lottery revenues, real estate transfer taxes, impact fees, and special district fees.

Some communities use TDR programs to protect agricultural lands and sensitive natural areas.[9] Under a TDR program, sensitive or vulnerable lands (such as floodplains or land in a river corridor) are zoned to restrict development and designated as a "sending area." Communities then designate "receiving areas" where they wish to see additional (denser) development. Those "receiving areas" are zoned to allow additional density. Landowners who own properties in a sending area are granted development credits for the development rights that have been reduced by the rezoning and can sell those credits to developers who wish to develop in a receiving area. TDR programs have been used successfully in many rural areas to preserve open space and agricultural lands including Montgomery County,[10] Maryland,[11] and the Pinelands of New Jersey.[12] TDR programs can be implemented in faster-growing areas with significant development pressure, but some rural regions or small towns may not have a rate of development needed to create a viable market for denser development at the municipal level. In these places, a TDR program implemented at a regional or county scale may be more effective.

Communities may also consider providing tax incentives to protect important land. For example, in Virginia, the state legislature passed a Riparian Buffer Tax Credit in 2000 that grants a tax credit

[ii] Specific incentives that may be offered by communities vary by state (e.g., enabling legislation is required in Dillon Rule states) and by community.

equal to 25% of the value of timber retained in a buffer up to $17,500. The buffer must be at least 35 feet wide and maintained for 15 years.[13]

To further enhance the ability of vulnerable land to accommodate flooding, some communities encourage riparian and wetland vegetation restoration. Restoring such vegetation can help absorb stormwater, decrease erosion, and reduce flooding associated with coastal storm surges. Restoring wetland and riparian vegetation is a major focus of Chesapeake Bay restoration efforts, including stream restoration projects in Baltimore County, Maryland.[14]

Some communities in the MRV and around the state are already implementing measures to acquire and protect vulnerable land. Prior to Tropical Storm Irene, for example, the Town of Warren, Vermont purchased two properties that had been flooded in the past, demolished the buildings on those properties, and created Riverside Park. During Tropical Storm Irene, the park flooded but was able to accommodate the floodwater without causing damage to surrounding buildings. The Vermont Land Trust and other organizations have also purchased land in fee or have placed conservation easements on 345 acres (or 15%) of the floodplain in the MRV, helping to protect land that can accommodate floodwater in the future.[15]

2. Encourage agricultural and other land owners to implement pre-disaster mitigation measures.

Agricultural land in floodplains can provide flood storage capacity and absorb stormwater runoff during heavy rain events, reducing flood-related damage and associated losses the community must bear. While agriculture-related development and land management practices are typically exempt from local regulation in many states, local communities can work with organizations that are partnering with the agricultural community to reduce flood risk and can purchase conservation easements on farmland (see section A.1., above) or provide other incentives to agricultural landowners to implement pre-disaster mitigation measures that may reduce flooding risk. One example of a pre-disaster mitigation measure is storing hay bales in areas less-likely to be flooded, since hay bales can be carried into the river during floods, clogging culverts and effectively serving as a dam downstream and inadvertently contributing to flooding along the riverbanks.

3. Adopt River Corridor/Fluvial Erosion Hazard zoning.

To further protect vulnerable land and avoid exacerbating downstream flooding, communities could adopt River Corridor or Fluvial Erosion Hazard (FEH) zoning for land along rivers and streams. Such zoning, which is based on mapped river corridors and flood hazard areas, can limit or prohibit development in floodplains and FEH areas. Some, but not all, Vermont communities currently have River Corridor/FEH maps that can provide the basis for such zoning, but in 2014, the state of Vermont will complete mapping of all major River Corridors statewide.

If communities choose to allow limited development in River Corridor/FEH areas, they could require compensatory flood storage to offset impacts on existing structures and public safety. However, this strategy may not reduce flooding risk as effectively as limiting development and redevelopment in these areas altogether.

Some communities that do not have River Corridor/FEH zoning currently restrict development in FEMA-designated floodplains, but those designated areas do not always represent the extent of land that is vulnerable to flooding. Other communities regulate land use in the floodplains based only on the National Flood Insurance Program (NFIP) requirements, which allow new structures, fill, and other uses in the floodplain, as long as the development meets minimum protective standards (i.e., residential structures are elevated). Experience in communities across the country demonstrates

that simply adopting the NFIP minimum standards may lead to increased flood damage and losses[16] by increasing the exposure of people and property to hazards.

If at all possible, communities with rivers or streams that are not included in the statewide River Corridor or FEH maps may wish to conduct river corridor assessments for those streams and use that data to adopt River Corridor/FEH zoning that is based on the best available science. For small upland streams, communities may simply adopt stream setback requirements or vegetated buffer requirements in lieu of river corridor or FEH zoning (see section D.5., below).

4. ***Adopt agricultural or open space zoning.***

Another zoning technique available to communities that wish to protect land to accommodate floodwater is agricultural or open space zoning, which can limit or prohibit development in agricultural or other natural areas by allowing a limited number of units per a large acreage of land. The Vermont Planning Information Center has information on open space and resource protection regulations that may be helpful.[17] This type of zoning technique is most effective if the allowed densities are one unit per 20 or more acres.

Some communities with agricultural or open space zoning currently allow development at densities of one unit per two to five acres. This density may inadvertently lead to spread-out, large lot development which may fail to protect agricultural lands and open space and fail to allow the effective absorption of stormwater runoff. Increasing the agricultural or open space zoning to require a minimum lot size of 20 acres or more may be more effective in preserving agricultural and open space uses and allowing more effective stormwater management. Many farming communities in Wisconsin and Minnesota[18,19] have adopted agricultural zoning that has a minimum lot size of 20 acres or more, and Blaine County (Sun Valley), Idaho adopted a resource conservation zone district that allows only one unit/160 acres. [20]

River Corridors or Fluvial Erosion Hazard (FEH) Corridors

Most flood damage in Vermont is the result of erosion rather than inundation. 75% of Vermont's rivers have been found to be unstable as a result of land use and practices to try to contain and direct their flow. Most of these reaches of river lack access to floodplains with the expected, natural frequency of rainstorms. River corridors (also called Fluvial Erosion Hazard, or FEH, areas) define the area that rivers need to move within, so that they can regain natural stability over time, and become less prone to severe flooding. Most Vermont municipalities regulate land use in floodplains based on minimum standards necessary to obtain national flood insurance through the National Flood Insurance Program. These standards are designed to protect insured structures from losses from inundation, but don't necessarily address erosion that is so common in Vermont.

River corridors include the river channel and adjacent lands needed for the river to adjust laterally over time and still maintain its natural stable form. Buildings and infrastructure constructed within the river corridor can be particularly vulnerable to fluvial erosion hazards, and new encroachments can increase the hazards confronting existing development. Therefore, communities may wish to consider limiting new development in these areas. River corridor maps are being produced in Vermont based on geomorphic studies, following an assessment protocol established by the Agency of Natural Resources (ANR) Rivers Program. Because it is not practical to conduct detailed geomorphic study on all perennial streams in order to generate river corridor data, the ANR Rivers Program uses watershed size and valley slope as criteria to recommend specific streams for river corridor mapping and others (smaller, steeper streams) for simple development setbacks.

Some communities are also adopting conservation/cluster subdivision ordinances that require new subdivisions to protect large tracts of intact open space (including sensitive natural areas like river

and stream corridors) while clustering development into a small section of the parcel. These types of ordinances may help conserve land that is important for retaining floodwater. The Meadowland Overlay District from the Town of Warren, Vermont provides an example of standards for sensitive siting of houses to protect agricultural meadowlands and scenic locations.[21]

B. Vulnerable Settlements: Where development already exists in vulnerable areas, protect people, buildings, and facilities to reduce future flooding risk.

Many historic downtowns are located along rivers and in floodplains, a fact that may contribute to their attractive character and may contribute to the town or region's economy. This development may represent significant investments in infrastructure over generations, and many communities may choose to repair and rebuild in these areas after flooding events because of their economic or social importance. If communities choose to rebuild in areas that are susceptible to future flooding, they can take some steps to reduce the damage that may occur in future flooding events, although they cannot eliminate these risks entirely. Changes to the National Flood Insurance Program (NFIP) may influence how communities consider protecting assets in vulnerable locations.[22]

Biggert-Waters Flood Insurance Reform Act of 2012

In 2012, Congress passed and the President signed the Biggert-Waters Flood Insurance Reform Act of 2012, which extends the National Flood Insurance Program (NFIP) for five years. It removes subsidized rates (pre- Flood Insurance Rate Map (FIRM) rates) for the following classes of structures and allows rates to increase by 25% per year until actuarial rates are achieved. Rate changes will have the greatest effect on properties located within a Special Flood Hazard Area (SFHA) that were constructed before a community adopted its first FIRM and have not been elevated.

1. Finance traditional protection methods.

Many communities that have experienced flooding from events like Tropical Storm Irene in Vermont or Hurricane Katrina in Mississippi and Louisiana have pursued traditional engineered approaches to protect development in these areas such as armoring riverbanks and coastal areas, channelizing rivers, and elevating or buying out structures in the floodplain. These approaches, while expensive, will likely continue to be used in the future, but can be combined with non-structural techniques in order to enhance their success.

One of the looming challenges to traditional structural engineered approaches to flood resilience is their cost. Armoring riverbanks and rebuilding and elevating structures can be very costly (and can cause future unintended flood damage upstream and down). Due to the costly nature of rebuilding new infrastructure, communities often look to the federal government to provide financial resources for these efforts. The major federal players include the U.S. Army Corps of Engineers (USACE), FEMA, the U.S. Department of Housing and Urban Development (HUD), and the U.S. Department of Transportation (DOT).

The USACE builds and repairs major flood control projects such as dams and levees, sometimes requiring a state or local match for the investment.[23]

FEMA has a number of funding programs including its public assistance program that provide local governments with funding to repair critical public infrastructure following a disaster.[24] For example, FEMA's Pre-Disaster Mitigation Grant Program and its Hazard Mitigation Grant Program (HMGP) assist in underwriting the cost of repairing and upgrading damaged public facilities. In addition, these programs provide funding to demolish, relocate, or elevate structures in hazard-prone areas such as Special Flood Hazard Areas.[25,26] In order to qualify for funding, the HMGP requires that

projects proposed for the purpose of reducing flooding risk or increasing resilience be included in the local hazard mitigation plan. FEMA has other programs[27] that local governments can use to repair and upgrade their damaged public facilities.

HUD has several programs that fund infrastructure construction and repair. Many small communities have funded flood-related capital improvements through the competitive Small Cities Community Development Block Grant program.[28] Local governments can, for example, use these funds for public drainage projects in advance of a flood. HUD is also active in the aftermath of a disaster, activating its Community Development Block Grant (CDBG) Disaster Recovery Funds.[29] In Vermont, HUD has delegated the administration of the HUD disaster funds to the Agency of Commerce and Community Development in accordance with its HUD-approved plan, Vermont's Community Development Block Grant Disaster Recovery Action Plan.[30] The regular CDBG program can also be used to implement flood-related projects.[31]

Finally, the DOT Federal Highway Administration makes funds available for road reconstruction due to flood damage.[32]

While states do not typically have flood disaster funding programs at the same scale as the federal government, they often make some level of assistance available to communities in the aftermath of a disaster as well. State funding agencies include transportation, community and economic development, health and the environment, and natural resources and agriculture.

2. Upgrade zoning regulations to protect structures that are rebuilt.

Many communities control floodplain development through special floodplain or flood hazard area zoning overlay districts with associated development standards. Many of these standards require the lowest floor of any structure in these districts to be elevated at least one foot above the base flood elevation (BFE). Communities could consider increasing this requirement to a minimum of two feet above BFE to provide an extra margin of safety. Lake County, Illinois[33] and Fort Collins, Colorado[34] have implemented these enhanced requirements, for example. While these enhanced standards may help protect structures in frequently-flooded areas, they may not eliminate flooding risk entirely. Alternatively, towns could consider prohibiting development in the floodway or floodplain entirely, to reduce risk further. Typically, development is allowed in floodplains if a registered professional engineer certifies it as being safe, unless a community specifically prohibits it.

Regulations for nonconforming structures and uses may also have an impact on a community's flood resilience. Many communities commonly place zoning and building code controls on the expansion or renovation of nonconforming structures and uses, with a goal of replacing or removing these structures over time. If a nonconforming structure or use that does not meet these standards is reconstructed or redeveloped following significant damage—"significant" typically means repair costs exceed a specified dollar amount or percentage of the structure's value—the new structure or use is required to be in full compliance will all current standards, including setbacks, height, and lot area. Moreover, nonconforming use zoning rarely allows any type of expansion, including elevating a building to make it more flood resistant.

While these nonconforming use regulations make sense in many circumstances, they can have unintended consequences in areas that have been or may be subject to major storm damage. Because full compliance with current standards may be costly, property owners may choose to undertake only minor repairs to make their structures habitable rather than invest in major renovations that might trigger nonconformity provisions. This unintended consequence of nonconformity provisions may lead to disinvestment in a storm-damaged area and may render

property more vulnerable to future floods. Additionally, some properties may be abandoned, leading to long-term blight in a neighborhood, loss of local government tax revenues, and potentially an increase in crime. Local governments also may have complicated approval procedures for renovations or expansions on nonconforming properties, which creates another hurdle to economic recovery in storm-damaged areas.

For example, many coastal areas in the country, particularly in the South, were platted and developed in the 1940s through the early 1960s, before implementation of the NFIP which required that structures be elevated one foot above the BFE or flood proofing. As a result, many communities in these regions have large stocks of development that do not comply with current flood damage prevention requirements. Often these homes and businesses fail to comply with zoning-related requirements such as setbacks, off-street parking, or design-related provisions. Because modifications to these older structures would trigger the requirement for full compliance with all development standards, which can be cost-prohibitive, these nonconformities continue unchanged through the years. Standards that allow identical replacement of these nonconforming structures following storm events are politically popular, but do little for the community's long-term flood resilience.

To address these problems, some communities are implementing nonconforming use regulations that recognize partial compliance with development standards and incorporate incentives for property owners to redevelop and/or reconstruct nonconforming structures using more hazard resilient techniques such as building elevation or floodproofing of HVAC equipment. Incentives for redeveloping nonconforming structures, when coupled with requirements for greater hazard resilience, can help increase the ability of development in flood-prone areas to withstand future floods.

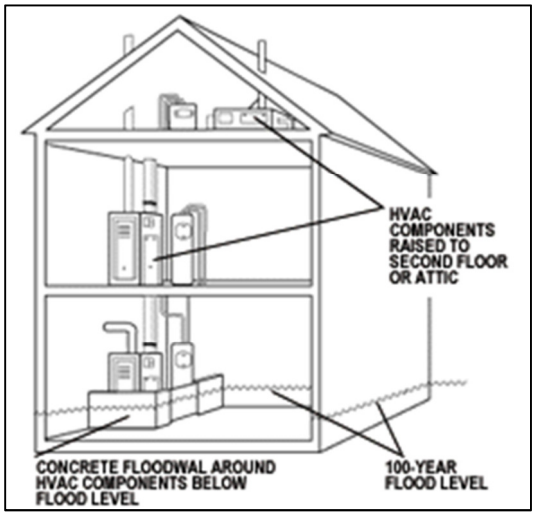
Modifications to the nonconforming provisions that provide an incentive for redevelopment (for example, expansion of floor area) can help home and business owners justify the costs of achieving compliance and can foster redevelopment that is more consistent with current zoning and building codes. Coupling these incentives for redevelopment with requirements for partial compliance with key development regulations (e.g., flood damage prevention standards within special flood hazard areas) can improve overall flood resilience more than if full compliance with all development regulations was required. In this situation, both the property owner and the community reap benefits. The home or business owner can increase the value of their property without incurring the expenditure of full code compliance, while the community benefits from a structure that is less likely to sustain serious damage during a future flood.

3. Upgrade or adopt building codes to promote safer development.

Adopting building code requirements for structures built or reconstructed in or near floodplains can help protect structures and people. However, in many states, building codes are governed by state law and cannot be modified by local governments. Some communities do not enact building codes at all. When local jurisdictions have control over their building codes and have the resources to administer such codes effectively, they could consider upgrading their standards to provide an extra margin of safety from flood damage. For example, the International Building Code and International Residential Code (which are either adopted directly or form the basis of most state building codes) reference FEMA, the National Flood Insurance Program, their maps and information, and the American Society of Civil Engineers (ASCE) Flood Resistant Design and Construction Standards 24-05.[35,36]

While each state and local jurisdiction has differing laws governing local authority to adopt or modify building codes, most local governments in the United States have the legal authority to adopt zoning provisions that respond to varying levels of risk including those related to flood and weather variability. Thus communities can use zoning codes, including overlay zone districts, as an alternative to building codes to enact requirements for flood mitigation and flood proofing activities.

If local governments have limited authority to vary from state-imposed building codes and do not choose to use zoning codes to enact flood mitigation requirements, they could provide incentives such as increased density or building height for the voluntary use of flood-resistant design and building standards, such as those outlined in the International Green Construction Code.[37]



Credit: Federal Emergency Management Agency.

Caption: This diagram illustrates how HVAC equipment can be raised or floodproofed in buildings located in areas at high risk of flooding.

4. Create new flood storage capacity through redevelopment.

When redevelopment opportunities arise in vulnerable areas next to rivers, communities can design redevelopment to include additional flood storage capacity. New flood storage capacity could mean creating parks and other open spaces in vulnerable locations, replacing a vertical wall along a river bank with a more gradual slope to create more room in the river channel for rising water, creating a shallow depression in a lawn that can accommodate inundation, or redesigning buildings to enable the first floor or basement to flood rather than armoring the buildings to repel rising waters.

5. Orient buildings and activities towards the river.

Development in many historic, riverfront towns and villages often faces away from the river. Except for at bridge crossings, community members may rarely see or consider the river as a part of community life – until a flood arrives. A river can be a social and economic asset if community members can safely access and interact with the riverfront. Opportunities to see and engage with the river could help communities plan for future flooding by increasing community members' consciousness of the rivers' presence. When redevelopment takes place in vulnerable settlements, communities can consider creating parks, outdoor dining and vending, river-based recreation like fishing and kayaking, and other activities that can withstand flooding and bring people closer to the river during normal flows.

6. Relocate people and assets to less vulnerable areas.

As certain structures are flooded time and again, some communities may evaluate the option of relocating them to safer areas. While relocating people and assets can be very expensive and politically challenging, there are some advantages to doing so. When considering relocating assets and people, it is particularly important to ensure that critical facilities such as healthcare facilities, town halls, fire and safety facilities, and wastewater facilities are moved to less vulnerable locations if possible.

For example, FEMA is interested in reducing the number of properties that are repeatedly damaged by flooding, since doing so will reduce federal costs for repairing and rebuilding flood damaged-structures. "Repetitive loss properties" comprise approximately one percent of insured properties but account for 25 to 30 percent of flood claims. FEMA's Flood Mitigation Assistance (FMA) Program is focused on reducing repetitively flooded structures. Under the FMA program applicants can seek funding under the repetitive loss or severely repetitive loss programs. These programs can be used to buy out or elevate structures that have been flooded repeatedly. However, there are prerequisites to qualify for funding. The local government where the structure is located must be enrolled in FEMA's National Flood Insurance Program. Additionally, to be eligible for the repetitive loss program, a property must have been flooded twice within any 10 year period. To be eligible for the severely repetitive loss program, the property must have been flooded four times within any 10 year period.

Some communities have created special funding mechanisms to support the buyout of properties that are susceptible to future flooding events. For example, in Napa, California, the community instituted a ½ cent sales tax to pay the local share of a federal flood control project that will result in the purchase of 350 properties.[38] Stormwater utility fees could also be used for this purpose (see section D.2., below). According to a study by the University of Maryland, a stormwater utility fee of $20 per residential unit could generate $500,000 to $10 million annually for counties with 25,000-500,000 households.[39]

Local jurisdictions may choose to create a pre-disaster anticipatory relocation fund when such a program is cost-effective (i.e., if the costs of anticipatory relocation are presumed to be less than the costs of post-disaster relocation). Communities considering this approach could first prepare a relocation assessment to identify: 1) the range of uses, services, and facilities eligible for funding; 2) priorities for protecting vulnerable areas; 3) potential impacts of the anticipated "event" (e.g., flooding) to both people and structures; and 4) the potential total funding created by each available source. Communities could also prepare a cost-benefit analysis for structures and infrastructure that compares: 1) anticipatory relocation; 2) post-impact relocation, and, where applicable; 3) status quo with no further action needed for the damaged service or infrastructure (e.g., a utility substation that will not be replaced). If a local government is considering the need to relocate residents, the community may wish to host a comprehensive community outreach program to determine residents' concerns and preferences for relocation. Based on this outreach, the community can determine what funding is needed to adopt that method.

For a relocation fund to be successful, it must be backed by a long-term, reliable funding source such as a dedicated sales tax. Additional available funding sources may include annual appropriations from the general fund, bond issuance, and potentially, where funding will be used to relocate infrastructure, a tap fee or stormwater utility fee. If vulnerable areas will be converted to natural or open spaces, funding may also be available from foundations, nonprofit land preservation organizations, federal government grants, or local/regional parks and recreation budgets. In addition to local funding, there may be opportunities to leverage federal assistance, such as that

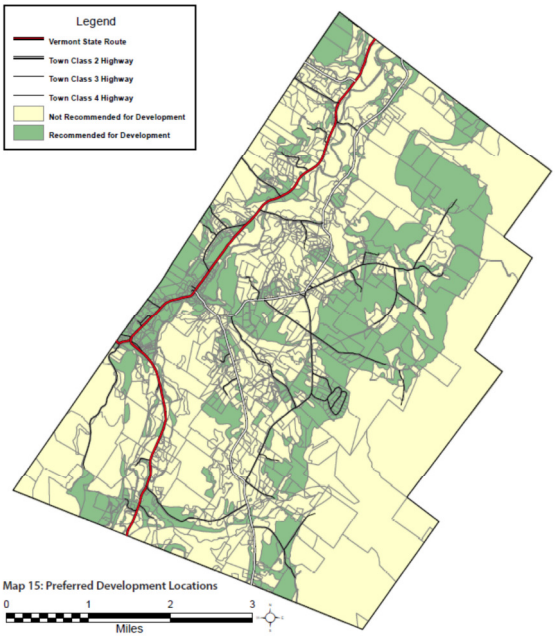
provided by the FEMA Pre-Disaster Mitigation Grant program (authorized by the Stafford Act) and HUD's CDBG program. The funds collected as part of the relocation fund can be provided directly to recipients as grants or could be used to underwrite low-interest loans for relocation costs.

C. Safer Areas: Plan for and encourage new development in areas that are less vulnerable to future flooding events.

Communities seeking to enhance their resilience to future flooding events can identify areas that are less vulnerable to flooding, where growth can occur more safely in the future. By encouraging development in these "safer growth" areas, communities can accommodate new growth while reducing flooding risk. Several policies can help direct growth into safer locations.

1. Identify locations suitable for development and redevelopment that are safer from flooding.

Communities interested in targeting growth in safer locations must first identify those locations in a land use plan or comprehensive plan. To identify where growth can occur more safely in the future, communities may need to access information about where flooding has occurred in the past, and to the extent possible, flooding projections for the future. Designating new nodes for development in the community's land use plan can signal to developers which locations the community has identified as a priority for development. Communities may wish to designate a desired density for these new nodes of development and may indicate if mixed-use development is desired for the area.



Credit: Waitsfield, Vermont, Town Plan.

Caption: The Waitsfield, Vermont Town Plan maps out areas that are recommended and not recommended for development.

2. Adopt policies to encourage development in safer locations.

Bringing residents, property owners, and other stakeholders together to develop a vision for how the community might accommodate new development in these locations can be very helpful. The community can incorporate that vision for future development into the comprehensive plan, revise

existing regulations or adopt new regulations necessary to implement the plan, and can plan new public facilities with the vision in mind.

Once communities have identified locations that are suitable for development, they can adopt and implement policies to encourage development in those locations such as targeting local government capital investments as discussed below.

3. Remove zoning and other land use regulatory barriers to development in safer locations.

Once safer growth areas are identified, communities can update their zoning and subdivision regulations to remove unnecessary barriers to development in those areas. If the local plan calls for denser residential development in targeted safer growth areas, local governments can ensure that land use regulations do not unintentionally inhibit development there. For example, if regulations do not allow multi-family developments or severely restrict the size or height of multi-family buildings, they may make it difficult to construct medium density developments (15-30 dwelling units per acre) that may be appropriate for area. Similarly, building front setback requirements and off-street parking standards that are excessive may require more land and increase the cost of development. Revising these requirements may encourage development in safer locations. For example, many communities require an off-street parking space for every 200 or 300 square feet of commercial building when one per 400 square feet is adequate in smaller jurisdictions.

4. Target capital improvements in safer locations.

Communities can target future capital improvements in locations that are designated by the community as safer growth areas by formally coordinating local capital improvement plans with community land use plans. By prioritizing capital improvements in safer areas, communities can provide incentives for development to locate there.

D. Upland and Everywhere: Implement stormwater management techniques to slow, spread and sink floodwater.

Communities that wish to become more resilient to future flooding events can also implement policies to more effectively manage stormwater. Adopting these policies can help slow stormwater, spread it out over a larger area, and allow it to sink into the ground rather than running off into nearby streams and rivers.

1. Address the management and regulation of roads, driveways, and parking lots.

Roads, driveways, and parking lots made of impervious surfaces do not allow stormwater to sink back into the ground and may increase stormwater volumes during heavy rains. Communities could consider implementing several policies that can reduce the risk that roads, driveways, and parking lots will exacerbate flooding and degrade water quality. First, they could encourage the use of pervious material in new driveways and parking lots, and in new roads where feasible. Communities could also require adequate culvert sizing[40] on private roads and manage town roads to a level that protects roads from damage during flooding. Improved management also keeps more roads in use despite flooding.

In many rural communities, roads and parking areas may be made of gravel, rather than asphalt. Communities with gravel roads and parking areas often protect them from damage by surrounding them with ditches, which drain the surfaces effectively but may also increase flooding by conveying stormwater directly into streams and rivers. To ensure that ditches around gravel surfaces do not inadvertently contribute to flooding risk, communities could enact public management policies for existing roads and parking areas and regulatory standards for new development that require water

collected in ditches to be dispersed before reaching water bodies. These policies and regulations can require techniques used to slow the flow of water by spreading it into vegetated areas and sinking it in areas with pervious soils. Communities can also encourage private landowners to adopt these practices for managing their driveways. Such techniques not only reduce flooding risk but can also improve water quality.

2. Explore watershed-wide stormwater management.

Flood damage mitigation measures, such as constructing levees or armoring banks, that are implemented in one jurisdiction within a watershed can have unintended consequences for other communities in that watershed. Recognizing this fact, some communities are joining together to take a regional and watershed-wide approach to stormwater management. To do this, communities can develop stormwater master plans for their watersheds and use river science and watershed modeling to understand more clearly what actions to take to absorb and slow down stormwater across the watershed to reduce flooding risk.[41]

Credit: Clarion Associates.

Caption: The City of Fort Collins, Colorado, takes a watershed approach to stormwater management and drainage improvement projects (Red Fox Meadows Natural/Stormwater Detention Area).

Some communities are also creating stormwater utilities to address stormwater management on a wider geographic basis. A stormwater utility is an entity established to generate and administer a dedicated source of funding for stormwater pollution prevention activities where users pay a fee based on land-use and contribution of runoff to the stormwater system.[42] Stormwater utilities can oversee stormwater management regulation and can help prioritize, coordinate, and finance critical pre-disaster mitigation efforts such as streambank restoration projects. A recent EPA publication, *Funding Stormwater Programs*, provides information on stormwater utilities and other ways to finance stormwater management programs.[43] The report includes case studies from South Burlington, Vermont and Newton, Massachusetts.

3. Adopt stormwater management regulations that include green infrastructure techniques.

While some communities in the United States have implemented comprehensive stormwater management regulations to comply with EPA or state requirements, other smaller, rural jurisdictions may not be required to implement such regulations. In Vermont, the state only regulates stormwater for developments exceeding one acre of impervious surface. However, stormwater runoff from developments with less than one acre of impervious surface may also contribute to flooding problems. Recognizing this fact, some communities are going above and beyond federal or state stormwater requirements to regulate stormwater throughout their communities.

Communities that are interested in improving stormwater management can consider requiring new developments to prepare stormwater management plans that use best management practices provided by federal, state, or other agencies. "Hard" engineering solutions such as underground cisterns are often used to meet these requirements, but "softer" green infrastructure approaches such as ponds, swales, or wetlands, could be considered as an alternative or supplement to structural solutions.[44] Green infrastructure can help retain and/or reuse stormwater near where it is generated and can be less costly and less environmentally damaging than traditional stormwater treatment.[45] Specific green infrastructure approaches include:[46]

- Reducing the amount of impervious surface by using pervious concrete, pavement, or pavers in suitable locations such as parking lots and driveways.
- Installing improvements that can retain or slow the flow of stormwater on small lots such as cisterns, rain barrels, and rain gardens.
- Incorporating practices such as bioswales and enhanced tree pits in public right of ways.
- Reusing rainwater onsite for landscaping, gardening, or irrigation (i.e., rainwater harvesting) in industrial, institutional, commercial, or residential lots.
- Integrating site or building stormwater management systems in order to capture most or all rainwater on site and put to beneficial use in individual buildings.
- Constructing green roofs or other rooftop retention elements such as small dams to induce storage and drain over a long period of time with passive controls such as small outlets that restrict the amount of stormwater that can exit.
- Installing large-scale practices such as constructed or natural wetlands, wet ponds, and dry ponds.
- Including storage underneath parking lots, streets, and sidewalks that can be designed to empty through passive controls such as small orifices into the sewer system or infiltration into the ground.

The Town of Williston, Vermont, has adopted stormwater management regulations that could serve as a model for other small communities.[47]

Credit: Clarion Associates.

Caption: Green infrastructure techniques such as rain gardens (left) and rain barrels (right) retain stormwater runoff on site.

In rural settings, forests, fields, and other open spaces can also capture and slow the flow of stormwater, particularly when combined with the techniques described above. Land managers of farms and forestlands often engage in practices to convey stormwater away from those lands for economic or aesthetic reasons, but they could choose to design their lands to accommodate occasional inundation through the use of rain gardens, depressions, ponds, swales, and plants that can tolerate occasional inundation, and by improving the porosity and water-retaining capability of the soils on their lands. Using such techniques can help reduce damage from flooding and can also help recharge aquifers.

4. Adopt tree canopy protection measures.

Communities can also slow, spread, and sink stormwater by protecting their existing trees. Large trees can absorb significant amounts of rain and can reduce stormwater velocity. To protect tree canopy, communities could start by preserving existing forested areas that contribute significantly to reducing stormwater runoff. Communities could also require larger existing trees, such as those that are greater than eight inches diameter at breast height (dbh), be preserved on a development site to the maximum extent feasible. Or, if those trees must be removed, a community could require that they be replaced at a minimum 1:1 caliper basis[iii] on-site or mitigated through payment into a municipal tree protection fund.[48]

Additional protection standards for trees during construction activities such as requiring fencing at the tree dripline can further support tree preservation goals. Communities could also implement requirements to retain a specified percentage of the tree canopy on a development site. For example, for a parcel that has 100% tree canopy cover, regulations might be designed to require that development on the site be placed so that 75% of the canopy is preserved. Currituck County, North Carolina and Folly Beach, South Carolina have tree protection codes that illustrate these approaches.[49,50]

5. Adopt stream setback requirements and vegetated buffer requirements.

Development along streams can contribute to stream instability and fluvial erosion. Communities can implement development setback requirements and vegetated buffer requirements on high gradient, small streams in order to slow, spread, and sink stormwater. Such requirements can limit or prohibit development in the area along a stream that is needed to accommodate physical stream stability and can allow stormwater to infiltrate into the soil and remove pollutants that would otherwise run off into local streams and rivers.

State programs such as the state of Vermont's Rivers Program[51] may be able to provide additional information on recommended practices for setback requirements. In general, studies show that in more rural areas a setback of 100 feet can significantly reduce stormwater runoff and improve water quality. [52] Smaller setbacks of 25-50 feet may be appropriate in more developed areas.

[iii] If a tree that measures 6 caliper inches is removed, it must be replaced with a total of 6 caliper inches of new trees.

Local bylaws can include vegetation requirements in defined riparian areas along streams and rivers. However, the benefits of such bylaws may be reduced if the stream's overall physical stability has been disrupted by development encroachment. Likewise, setback requirements are designed to minimize development near streams but may not require natural vegetation along the streams. For this reason, the state of Vermont's Rivers Program recommends vegetated buffers and setback requirements as complementary strategies to reduce risk of damage to structures along streams.

A "vegetated buffer" is an area of land along a river or stream that has undisturbed vegetation. Vegetated buffers have many benefits including enhancing water quality in adjacent rivers and streams and providing natural habitat for animals and plants. Vegetated buffers can increase stormwater infiltration and reduce runoff, stabilize banks, and slow floodwaters.

6. Adopt steep slope development regulations.

Development on steep slopes can cause erosion and can increase stormwater volumes. However, regulation of steep slope development varies widely in communities across the nation. Some communities with a history of landslides, mudslides, or earthquakes have implemented standards that prohibit building on steep slopes or reduce the density of residential development allowed in those areas. But many other communities merely caution against building on steep slopes or are altogether silent on the topic. Some communities are beginning to recognize that development on steep slopes can affect stormwater volumes and erosion and are adopting standards that discourage or prohibit development on very steep slopes in excess of 30% and reduce allowable densities in those areas. Williston, Vermont provides an example of steep slope development regulations.[53]

Credit: Vermont Stormwater Program.

Caption: Development on steep slopes and poor erosion control methods, as illustrated above, can cause erosion and increase the quantity of stormwater runoff. Steep slope development regulations can help prevent some of these impacts.

Appendix A: Community Checklist to Improve Long-Term Flood Resilience

Overall Strategies to Enhance Resilience		
1. Does the community comprehensive plan have a hazard element that includes flood planning or is addressed in another section of the plan?	☐ Yes	☐ No
a. Does the community plan cross reference the local hazard mitigation plan (HMP) and any disaster recovery plans?	☐ Yes	☐ No
b. Does the community plan identify flood-prone areas, including River Corridor/Fluvial Erosion Hazard areas, if applicable?	☐ Yes	☐ No
c. Did the local government emergency response personnel, floodplain manager, or department of public works participate in the community plan process?	☐ Yes	☐ No
d. Is the community planner a member of the American Institute of Certified Planners or the Association of State Floodplain Managers?	☐ Yes	☐ No
2. Does the community have a FEMA and state EMS-approved hazard mitigation plan?	☐ Yes	☐ No
a. Does the HMP cross-reference the comprehensive plan?	☐ Yes	☐ No
b. Was the local government planner or zoning administrator involved in the HMP process?	☐ Yes	☐ No
c. Were other groups such as local businesses, schools, medical communities, farmers, etc. involved in the HMP drafting process? Were other local governments in the watershed involved to coordinate responses and strategies?	☐ Yes	☐ No
d. Does the HMP focus on non-structural pre-disaster mitigation measures such as bylaw adoption and zoning code amendments?	☐ Yes	☐ No
e. Does the HMP address improved stormwater management standards that include green infrastructure techniques?	☐ Yes	☐ No
3. Are structural/engineering flood mitigation approaches (e.g., repairing bridges and levees, armoring river banks, etc.) coordinated with the local capital improvement plans and budget?	☐ Yes	☐ No
River Corridors: Conserve Land and Avoid Development		
1. Do local land development regulations (zoning, subdivision, etc.) incorporate approaches and standards to protect vulnerable areas such as floodplain areas and wetlands that can help reduce flooding and flood damage? Such as:	☐ Yes	☐ No
a. Areas subject to flooding, including mapped river corridors and Special Flood Hazard Areas (except in very compact, already-developed areas where infill development may be encouraged).	☐ Yes	☐ No

b. Maintenance of vegetated riparian buffers?	☐ Yes	☐ No
c. Control of development on steep slopes?	☐ Yes	☐ No
d. Tree and vegetation protection and erosion control during construction?	☐ Yes	☐ No
e. Preservation of agricultural land and open space?	☐ Yes	☐ No
2. Has the community adopted bylaws that go beyond FEMA's minimum standards for Special Flood Hazard Areas and also prohibit any new encroachment and fill in Fluvial Erosion Hazard areas (if applicable)?	☐ Yes	☐ No
3. Does the community participate in the National Flood Insurance Program Community Rating System?	☐ Yes	☐ No
4. Has the community adopted complements to regulations to promote flood resilience such as:	☐ Yes	☐ No
a. Transferable and purchase of development rights programs?	☐ Yes	☐ No
b. Acquisition of land (or conservation easements on land) that allows for stormwater absorption, river channel adjustment, or other benefits?	☐ Yes	☐ No
c. Prohibiting investing in capital improvements that may encourage development in vulnerable areas?	☐ Yes	☐ No
<u>Vulnerable Settlements: Protect People, Buildings, and Facilities</u>		
1. Do the local comprehensive plan and HMP identify vulnerable areas that have been or are likely to be subject to flooding?	☐ Yes	☐ No
a. If so, is development in those areas discouraged or subject to strategies to improve safe rebuilding?	☐ Yes	☐ No
b. Does the HMP identify critical facilities and infrastructure that could be protected, repaired, or relocated (e.g., bridges, roads, wastewater facilities)?	☐ Yes	☐ No
c. Does the plan identify projects that could be included in pre-disaster grant applications?	☐ Yes	☐ No
2. Have land development regulations and building codes been upgraded to promote safer rebuilding in flood-prone areas? Does the community plan for costs associated with follow-up inspection and enforcement?	☐ Yes	☐ No
a. Has community adopted the International Building Code or ASCE design standards to promote safe flood-resistant design and construction?	☐ Yes	☐ No
b. Do zoning or floodplain regulations require elevation to two feet or more above base flood elevation?	☐ Yes	☐ No
c. Is development in floodways prohibited?	☐ Yes	☐ No

d. Have non-conforming use and structure standards been revised to encourage safer rebuilding in flood prone areas?	☐ Yes	☐ No
e. Has the community adopted a cumulative substantial damage ordinance?	☐ Yes	☐ No
f. Does the community have the ability to establish a temporary post-disaster building moratorium?	☐ Yes	☐ No
3. Does the comprehensive plan or HMP discuss strategies to relocate people and structures in areas that have been repeatedly flooded, including potential funding sources (e.g., FEMA funds, stormwater utility, special assessment district)?	☐ Yes	☐ No
<u>Safer Areas: Plan for and Encourage New Development</u>		
1. Does the local comprehensive plan or HMP clearly identify safer growth areas in the community and adopt policies to encourage development in these areas?	☐ Yes	☐ No
2. Has the community undertaken detailed development planning that encourages smart growth in safer areas?	☐ Yes	☐ No
3. Have land development regulations been audited to remove unnecessary impediments to development in safer areas (e.g., excessive off-street parking requirements, limits on residential height and density, large front-yard setback standards)?	☐ Yes	☐ No
4. Do capital improvement plans and budgets support development in preferred safer growth areas (such as investment in wastewater treatment facilities and roads)?	☐ Yes	☐ No
5. Have building codes been upgraded to promote safer development in areas that could be subject to future hazards?	☐ Yes	☐ No
<u>Upland and Everywhere: Slow It, Spread It, Sink It</u>		
1. Does the community have regulatory and non-regulatory stormwater approaches in place to reduce runoff volumes and velocity that can increase flood damage?	☐ Yes	☐ No
a. Are green infrastructure techniques allowed or encouraged in the stormwater regulations?	☐ Yes	☐ No
b. Has the local government explored funding sources for stormwater management such as a stormwater utility?	☐ Yes	☐ No
c. Has the local government explored regional watershed stormwater management with other area jurisdictions?	☐ Yes	☐ No
d. Do local stormwater regulations apply to projects that fall below the threshold for state stormwater regulations?	☐ Yes	☐ No
2. Has the local government undertaken or encouraged riparian area restoration projects in areas subject to erosion and flooding?	☐ Yes	☐ No

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